PATENT ABSTRACTS OF JAPAN

(11)Publication number : 09-070675

(43)Date of publication of application : 18.03.1997

(51)Int.Cl. B23K 11/24
B23K 11/24
B23K 11/11
B25J 9/22

(21)Application number : 07-255517

(22)Date of filing : 06.09.1995

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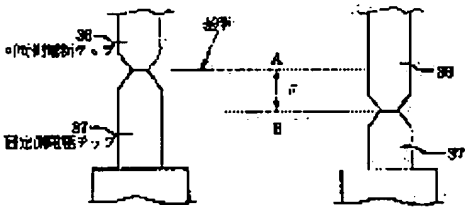
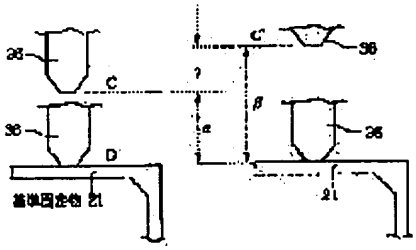
(54) CONTROLLER OF ROBOT FOR SPOT WELDING AND ITS CONTROL METHOD

(57)Abstract:

PROBLEM TO BE SOLVED: To shorten the date schedules for design and installation and to reduce a cost by automating the management of an electrode tip from the position correction of this tip based on wear.

SOLUTION: The position A of the moving side electrode tip 36 is stored by executing idle stroke with a reference electrode tip at the time of teaching. An approach position C where the moving side electrode tip 36 may be pressed to a reference stationary object 21 is taught in a robot by moving this robot. The moving side electrode tip 36 is pressed to the reference stationary object 21 and the difference from the position D of the tip 36 is stored. Next, the previously taught idle stroke is reproduced and the difference δ between the position B of the electrode tip 36 and the position A at the time of the teaching is calculated. This difference δ is the first total abrasion loss. The contact with the reference stationary object 21 is likewise reproduced and the difference β between the approach position C' and the position D of the electrode tip 36 is detected. As a result, δ: the first total abrasion loss, i.e., the first





moving side correction rate, α: a reference stroke length, β: the stroke length at the time of the first wear, γ=β-α: the first moving side abrasion loss, ε=δ-(β-α): the first stationary side correction rate are attained.

LEGAL STATUS

[Date of request for examination]	20.09.2001
[Date of sending the examiner's decision of rejection]	
[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]	
[Date of final disposal for application]	
[Patent number]	3551339
[Date of registration]	14.05.2004
[Number of appeal against examiner's decision of rejection]	
[Date of requesting appeal against examiner's decision of rejection]	
[Date of extinction of right]	

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to control unit and its control approach of the robot for spot welding.
[0002]
[Description of the Prior Art] Conventionally, by the spot welding in a robot, the spot gun for welding was absorbing and welding the impact and electrode abrasion loss of a robot and a work piece by equalizing during pressurization (equalize) [this is hereafter called "conventional example 1"]. (Moreover, the policy, for example, JP,6-79787,B, of wear detection JP,6-27273,Y It was a means [these are hereafter called "the conventional example 2 and conventional example 3"] to form and detect the sensor of dedication to a gun or the exterior, like.) Furthermore, about chip exchange, it fabricated by the count which welded, and was based on the amount of detection which exchanged by the count of shaping or was obtained from said sensor of the conventional example 2 and the conventional example 3 [this is hereafter called "conventional example 4"]. And like the example of a system shown in drawing 7 as a processing means of the abnormalities in a transformer thermostat , when it have been arranged at the welding timer and the welding timer detected the abnormalities in a thermostat of a transformer during operation , the thermostat signal line of the welding transformer of a gun be unified with other factors by having made this into the abnormalities in welding , be outputted to robot control equipment , and be processed as an abnormality alarm in welding as a robot . That is, in drawing 7 as an example of wiring of the conventional example, the spot robot 10 equips with the spot gun 30, and from the spot gun 30, the gun control cable 22 is wired as a gun control signal line 23 through the junction section 25 to robot control equipment 15, and, on the other hand, he is wired through the junction section 25 as a transformer thermostat signal line 24 to the welding timer 20. From robot control equipment 15, the welding signal line 28 is connected to the welding timer 20, and it connects with it with the power cable 29 to the transformer 32 of the spot gun 30. in addition, the electric supply cable for the current supply to the drive motor with which 11 carries out attitude control of the spot robot 10 and the programming pendant for robots in 16 (programming pendant) [it is -- this is hereafter called "conventional example 5"]. By the conventional robot's electric spot gun welding further again When it is necessary to make a fixed side electrode contact a work piece, and to teach that location and this instruction is carried out, Move a fixed side electrode a slight amount every, a work piece is made to contact, and it teaches, or has an equalizing device to a gun, and it enabled it to weld even if it did not carry out contact instruction to a work piece as instruction of a robot [this is hereafter called "conventional example 6"]. If it ****** for a while about an equalizing device, it will be what supports a welding gun possible [displacement] in the pressurization direction here. When it is a means by which it was made to absorb a location gap of a weldment-ed, for example, a migration lateral electrode contacts a work piece in pressurization actuation of a migration lateral electrode As the fixed lock of a fixed side electrode comes loose, a fixed side electrode will be in a rockable condition with a spring means and a location gap of a weldment-ed is lost, it is the device in which a fixed side electrode contacts a weldment-ed based on previous rocking. If

it elaborates on the advanced technology by the reference [thing mentioned above / reference / previously], by the way, the conventional example 2 In the automatic welding machine which welds a welding gun to two or more RBI locations of a work piece by carrying out sequential migration with a robot Opening of the gun arm when ******(ing) a welding gun, where the new electrode tip of the dimension of normal is attached is made into criteria opening. A welding gun is ******(ed), before the die length of the electrode tip sets up the minimum opening of a wanting-to decrease to use limitation gun arm and welds the RBI location of the beginning of a work piece. While the opening sensor which prepared the opening of the gun arm at this time in the welding gun detects, measuring this detection opening and said minimum opening and distinguishing the existence of the need for exchange of the electrode tip When the upper limit opening which added the allowable error to said criteria opening is set up and said detection opening exceeds this upper limit opening, it is the electrode tip management method of the welding gun in the automatic welding machine characterized by making the indicator which shows a poor chip operate. In addition, the conventional example 3 is set to the welding robot equipment which made the arm of a robot body carry out floating support of the welding unit through an equalizer. The electrode location compensator to which the variation rate of the location of the welding unit to the above-mentioned arm is made to carry out in the electrode opposite direction, The abrasion loss detection equipment which detects the abrasion loss of the fixed electrode of a welding unit, It is welding robot equipment characterized by having the control device operated so that the location of a fixed electrode [as opposed to an arm for the above-mentioned abrasion loss detection equipment] may be amended to an initial valve position based on the electrode abrasion loss detected with this abrasion loss detection equipment.

[0003]

[Problem(s) to be Solved by the Invention] However, the equalizing device of the conventional example 1 thru/or the conventional example 4 restricted the freedom of a gun design, and the sensor had become the cause of the others' and both who are difficult [enforcement] etc. a cost rise from the welding environment. Then, this invention sets it as the 1st purpose to offer control unit and approach of the robot for spot welding which the abrasion loss of a chip is detected without using an equalizing device, a sensor, etc., and can detect abrasion loss amendment and a chip exchange stage. Furthermore, the gun from which a stroke differs appears by the approach of the conventional example 5, in these days which it came to carry out with robot control equipment, only Rhine which transmits the thermostat output signal of a welding transformer will wire a welder from a gun, and control of a spot gun has the bad effectiveness on a design and enforcement. Moreover, since the abnormalities which should be able to be taken as an individual factor of the abnormalities in a transformer thermostat were taken as robot control equipment only in the form unified as abnormalities in welding, there was a trouble of being hard to carry out fine management. Then, this invention sets it as the 2nd purpose to offer the control unit of the robot for spot welding with monitor / processing means of this signal so that the thermostat signal of a spot gun may be wired directly. By the instruction approach in the robot for spot welding looked at by the conventional example 6, the instruction which a fixed side electrode is made to contact to a work piece was difficult, there are troubles, like it also takes time amount, and the equalizing device had become the cause of a cost rise further again. Then, this invention is an easy approach and sets it as the 3rd purpose to offer control unit and approach of the robot for spot welding which can teach the contact location of a fixed side electrode.

[0004]

[Means for Solving the Problem] In the robot control equipment with which this invention welds a weldment-ed by resistance from an electric spot gun in order to solve the above-mentioned technical problem Without using an equalizing device, a sensor, etc. from the attainment location at the time of the drive of an electric spot gun It is robot control equipment for spot welding which detects the abrasion loss of a chip and carries out detection at the time of abrasion loss amendment and chip exchange. Moreover, it is robot control equipment for spot welding with monitor / processing means of the thermostat signal of the welding transformer of a spot gun, and in the robot which welds a weldment-ed by resistance further, it is an easy means, and is robot control equipment for spot welding

which can teach the contact location of a fixed side electrode. Namely, it sets to the equipment which controls the robot which welds a weldment-ed by resistance by the electric spot gun. A means to ****** with the electrode tip of criteria at the time of instruction, and a means to make a movable side electrode contact the anchorage used as criteria, A means to make said ****** and robot location at the time of contact, and a gun motor location memorize, A means to compute the amount of amendments which performs ****** with the electrode tip currently used at the time of program playback, is made to contact an anchorage again, and can be found with the difference of a location with the time of instruction from each abrasion loss and it of the movable side electrode tip and the fixed side electrode tip, It is the control unit of the robot for spot welding which has a means to perform actuation which amends the location of said movable side electrode tip and the fixed side electrode tip in said amount of amendments. Moreover, ****** at the time of instruction and the location A of said movable side electrode tip at this time is memorized. Move a robot to a criteria anchorage and the approach location C which can contact the movable side electrode tip is taught to it. Make the movable side electrode tip contact a criteria anchorage from a location C, and the movement magnitude of the location of the gun motor of the difference alpha with the location D of the movable side electrode tip at this time is memorized. The same ****** and criteria anchorage contact are taught to the program at the time of a chip dress or chip exchange. ****** taught at the time of program playback of a chip dress or chip exchange is reproduced. The difference delta of the location of the gun motor of the location B of the movable side electrode tip and the location A at the time of instruction is computed. This difference delta serves as the 1st ** (movable side + fixed side) abrasion loss, and the contact to the criteria anchorage similarly taught is reproduced. The difference beta of approach location C' and a location D is detected. delta: -- the 1st ** (movable side + fixed side) abrasion loss, i.e., amount of movable side amendments alpha:criteria length-of-stroke beta[of ** a 1st]:, -- the time of the 1st wear -- length-of-stroke gamma=beta-alpha: -- 1st movable side abrasion loss epsilon=delta-(beta-alpha): -- as the 1st fixed side abrasion loss of fixed side amendments, i.e., 1st amount It is the control approach of the robot for spot welding which amends the movable side electrode tip in the 1st amount of movable side amendments shown by delta, and amends said fixed side electrode tip with the 1st fixed side abrasion loss shown by epsilon. A means to make the gun motor location of the location of the movable side electrode tip memorize in the state of the same pressurization as the time of welding at a criteria work piece furthermore in the case of instruction, or to make the gun motor location, the board thickness, and the welding number of sheets of a location of ****** memorize, With the electrode currently used at the time of program playback, spot welding It has a means to compute the 2nd abrasion loss which carried out and added each abrasion loss of the movable side electrode tip and the fixed side electrode tip from the location of the movable side electrode tip at this time, and to compute the 2nd amount of amendments of the movable side electrode tip and the fixed side electrode tip from this, the 1st abrasion loss, and the 1st amount of amendments. It is the control unit of the robot for spot welding given in the 1st term which amends wear of the electrode tip between the calculation periods of the 1st amount of amendments based on the 2nd amount of amendments. What had registered the location of the movable side electrode tip in the state of pressurization beforehand in the location of a gun motor further again, this time -- difference delta' with the location of the gun motor of the pressurization location under welding -- computing -- delta': -- the 2nd ** (movable side + fixed side) abrasion loss, i.e., amount of movable side amendments of ** 2nd epsilon', -- =epsilon+{(delta' - delta) /2}: -- from the 2nd fixed side abrasion loss of fixed side amendments, i.e., the 2nd amount It is the control approach of the robot for spot welding given in the 2nd term which computes and amends at the time of program playback of welding actuation. 2nd amount of movable side amendments delta', and the 2nd amount of fixed side amendments -- epsilon' -- In addition, when it has a means to memorize the use marginal abrasion loss of the movable side electrode tip and the fixed side electrode tip and the 1st abrasion loss exceeds the value of use marginal abrasion loss It is the control unit of the robot for spot welding given in the 1st term which outputs an alarm signal or carries out automatic chip exchange. In addition, [and] [whether when the 2nd total abrasion loss exceeds the value adding the movable side electrode tip and the fixed side electrode tip of the use marginal abrasion loss set up beforehand, an alarm signal is outputted after

ending welding, and] Or the 1st abrasion loss of the movable side electrode tip and the fixed side electrode tip is computed. It is the control unit of the robot for spot welding given in the 1st term to which it judges whether it is a use limitation, and an alarm signal is outputted or which chip carries out automatic chip exchange. And it sets to the equipment which controls the robot which welds a weldment-ed by resistance by the spot gun. A means to input the thermostat signal of the welding transformer of a spot gun, In the equipment which controls the robot which is the control unit of the robot for spot welding which has a means to suspend welding actuation with the signal, and a means to output an alarm, and welds a weldment-ed by resistance from a moreover in addition gun motorised spot gun The board thickness of a work piece, a means to set up welding number of sheets, and a means to move a fixed side electrode to a welding location with a robot shaft at the time of instruction, A means to make a movable side electrode contact a work piece, and a means to compute the movement magnitude for making a fixed side chip contact from said gun motor location at the time of contact, It is the control unit of the robot for spot welding having a means to compute and teach the location which a fixed side electrode is made to contact from this movement magnitude. And the location p of the gun motor of the criteria location of the movable side electrode tip at the time of ****** is registered again. Set up thickness s and the welding number of sheets t of the work-piece conditions for instruction, and a robot is operated. When teach positioning of the vertical direction of a gun to the location of the approach for welding, the movable side electrode tip is made to contact slowly in the state of contact torque detection of the gun motor of a contact executive state and the location of contact is set to q, it is the 3rd amount eta of amendments which carries out teaching eta=(p-q)-(secondxt)
It is the control approach of the robot for spot welding which asks by carrying out and teaches with this contact condition.

[0005]

[Function] With the above-mentioned means, in the environment which does not almost have a location gap of a work piece, this invention can lose an equalizing device and a sensor and can aim at design, simplification of enforcement, and schedule compaction and reduction of cost. With the above-mentioned means, since all in connection with a spot gun including the pressurization signal of a gun, a stroke change-over signal, an open acknowledge signal, and the thermostat signal of a transformer can wire only robot control equipment, the effectiveness on a design / enforcement becomes good, and this invention can also expect cost reduction. Moreover, the thermostat signal of the transformer of a spot gun can be separately recognized not as the form unified as abnormalities in welding by wiring direct robot control equipment but as abnormalities in a thermostat of a transformer, fine management is attained, and safety and working efficiency also improve. With the above-mentioned means, the contact location of a fixed side electrode can be taught easily, and expansion of the degree of freedom of a gun design, reduction of cost, etc. can be expected by the abbreviation of an equalizing device according to concomitant use with wear amendment from a gun without an equalizing device by compaction of the instruction time amount of contact instruction, and the gun with an equalizing device.

[0006]

[Example] Hereafter, each example of this invention is explained based on a drawing. In addition, in each drawing, the same sign expresses the same or a considerable member. The notional perspective view and drawing 2 to which drawing 1 expresses an example of the system by which this invention is applied are the side elevation showing the electric spot gun in the 1st example of this invention. In drawing 1 and drawing 2 , the spot robot 10 equips with the electric spot gun 30, and the power cable (for welding) 29 is connected to the welding timer 20 from robot control equipment 15 by the welding control signal line 28 and the transformer 32 for welding of the electric spot gun 30. Moreover, robot control equipment 15 performs control of the electric motor 31 of the electric spot gun 30, and the movable side electrode tip 36 at the tip of the movable side polar zone 34 carries out pressurization to a work piece (un-illustrating), and actuation of disconnection through the mechanical component 33 which consists of the ball screw which drives an electric motor 31. The fixed side electrode tip 37 at the tip of the fixed side polar zone 35 has acquired the high current at the time of welding with the movable side electrode tip 36 from the welding transformer 32 further again. And the partial side elevation in

which drawing 3 shows the configuration of the 1st example of this invention, and drawing 4 are the partial side elevations showing the configuration of the 2nd example of this invention. Detection and abrasion loss amendment of a chip exchange stage by this system are as follows here.

[0007] The 1st amendment performed at the time of a chip dress or chip exchange is explained below as the 1st example of this invention at the beginning of [amendment performed at the time of the chip dress (chip polishing) of an electric spot gun, or chip exchange]. Drawing 3 is the explanatory view of the amendment performed at the time of a chip dress or chip exchange. First, ****** is carried out with the electrode tip of criteria like drawing 3 (a1) in the case of instruction. The location A of the movable side electrode tip 36 in this case (location of the gun motor 31) is memorized. That is, it ****** with the chip of criteria and the criteria location A of the movable side (above) electrode tip 36 is registered. Moreover, like drawing 3 (b1), move a robot to the criteria anchorage 21, teach the approach location C which can contact the movable side electrode tip 36 to it, the movable side electrode tip 36 is made to contact the criteria anchorage 21 from this approach location C, and the difference alpha with the location D of the movable side electrode tip 36 at this time (movement magnitude of the location of the gun motor 31) is memorized. The same ****** and criteria anchorage contact are taught to the program at the time of a chip dress or chip exchange at this time.

[0008] Next, ****** taught at the time of program playback of a chip dress or chip exchange is reproduced like drawing 3 (a2), and the difference delta of the location B of the movable side electrode tip 36 (location of the gun motor 31) and the location A at the time of instruction is computed. This difference delta serves as the 1st ** (movable side + fixed side) abrasion loss. And the contact to the criteria anchorage 21 similarly taught is reproduced, and the difference beta of the location D (the location of the gun motor 31 D+ movable chip abrasion loss) of approach location C' (the location which shifted from C a part of a movable chip worn out, the location as C where the location of the gun motor 31 is the same), and the movable side electrode tip 36 is detected. thereby -- delta: -- the 1st ** (movable side + fixed side) abrasion loss, i.e., amount of movable side amendments alpha:criteria length-of-stroke beta[of ** a 1st]:, -- the time of the 1st wear -- length-of-stroke gamma=beta-alpha: -- 1st movable side abrasion loss epsilon=delta-(beta-alpha): -- it becomes the 1st fixed side abrasion loss of fixed side amendments, i.e., the 1st amount.

[0009] Here, if it remains as it is when only the 1st amount of fixed side amendments amends the fixed side electrode tip 37 in the direction of a movable side, it is that of [refer to [of drawing 2] the device] by which the movable side electrode tip 36 also runs so much that delta becomes the 1st amount of movable side amendments, and it needs to amend only tales doses to hard flow. Thus, this invention consists of the following view fundamentally. Namely, fixed side abrasion loss = fixed side abrasion loss fixed side abrasion loss + movable side abrasion loss = relation called the amount of movable side amendments is materialized. When this is explained concretely, the abrasion loss of the fixed side electrode tip 37 abrasion loss of the movable side electrode tip 36 is performed by servo location amendment of the electric spot gun 30, and [offsets then the spot robot's 10 location amendment mentioned later] will amend the spot robot's 10 location.

[0010] It [amendment [which is performed in the case of the instruction at the time of program playback of welding actuation of an electric spot gun]] Ranks second, and the 2nd amendment performed in the case of instruction at the time of program playback of welding actuation is explained as the 2nd example of this invention. About the location (location of the approach for usually welding) set up so that this 2nd amendment might be carried out, each electrode is operated, after performing further amendment for the 1st amount delta of movable amendments, and the 1st amount epsilon of fixed side amendments. Although at least this can fully use the amendment at the time of the chip dress described previously or chip exchange but, if it amends in the case of the instruction at the time of program playback of welding actuation, the further welding precision will be acquired. That is, suppose that it is a setup which carries out the amount calculation of amendments at the time of welding in this case in the case of instruction actuation. Difference delta' of the pressurization location under welding (location of the gun motor 31) is computed this time with what had taken the location (location of the gun motor 31) of the movable side electrode tip 36 in the state of pressurization beforehand, and the 2nd amount of movable side

amendments and the 2nd amount of fixed side amendments are computed from the following formulas. delta': -- the 2nd ** (movable side + fixed side) abrasion loss, i.e., amount of movable side amendments of ** 2nd epsilon', -- =epsilon+{(delta' - delta) /2}: -- the 2nd fixed side abrasion loss of fixed side amendments, i.e., the 2nd amount, -- this When the 1st amendment at the time of the above-mentioned chip dress or chip exchange is used, from the last chip dress or the 3rd total abrasion loss (delta' - delta) from the amendment at the time of chip exchange to current, it assumes that the movable side electrode tip 36 and the fixed side electrode tip 37 were equally worn out, and amends.

[0011] moreover -- if it calculates as the 1st fixed side abrasion loss, the 1st amount epsilon= 0 of fixed side amendments, and the 1st ** (movable side + fixed side) abrasion loss and the 1st amount delta= 0 of movable side amendments while not using the 1st amendment at the time of a chip dress or chip exchange -- as a simple amendment means -- the 2nd amendment at the time of welding -- it can be used. The 2nd amendment actuation carries out and the way is the same as that of the time of the amendment at the time of the 1st chip dress or chip exchange. If all 2nd abrasion loss delta' computed at the time of spot welding is over the value adding the use marginal abrasion loss of the movable side electrode tip 36 made to memorize beforehand and the fixed side electrode tip 37, moreover, in a chip dress or the same procedure as the amendment at the time of chip exchange The 1st abrasion loss of the movable side electrode tip 36 and the fixed side electrode tip 37 is computed. It is also possible to perform the program which outputs an exchange demand signal or carries out automatic chip exchange automatically [which electrode tip judges whether it is a use limitation, and a robot evacuates to an electrode tip exchange location at the time, and]. If abrasion loss detection and the amendment function of a chip are made periodic timely as mentioned above, it will also become possible to automate management of a chip. Moreover, more suitable amendment will be attained if the amendment at the time of a chip dress or chip exchange and the amendment at the time of welding are used together.

[0012] [Control wiring means in control unit of robot for air spot gun welding] drawing 5 is a conceptual diagram which expresses the circuitry to the wiring list of the 3rd example of this invention. In addition, although the air spot gun 30 is used in this example, it cannot be overemphasized that the electric spot gun 30 may be applied. In this example shown here, directly, it connects with robot control equipment 15, and it wires so that all signals including a transformer thermostat signal may be transmitted, without the gun control cable 22 from the air [electric [or]] spot gun 30 going via the junction section 25, as shown in drawing 5 . That is, by drawing 7 of the conventional example, the transformer thermostat signal line 24 of what is wired from the gun control cable 22 with the signal in connection with other gun control signal cables to direct and robot control equipment 15, and is wired from the air spot gun 30 at a welder 20 of the air spot gun 30 currently wired by only one welder 20 is lost from the air spot gun 30 by drawing 5 of this example, and it is efficient. Moreover, it becomes, without coming to be able to perform processing of considering as an alarm and investigating a welder, after returning to safe posture and location that it is easy to operate a robot because the reason understands it to be the abnormalities in a transformer thermostat for the robot side to have stopped and to have investigated the welder about the cause, since it was collected as abnormalities in welding until now.

[0013] The thing mentioned above [it does not have an equalizing device and / without instruction / a means by which the fixed side electrode amendment which was suitable for the right time in the work piece of two or more sheets is made] for every welding as the 4th example of [instruction means of work-piece contact location of the fixed side electrode tip in control device of robot for electric spot gun welding] this invention. Hereafter, this example is explained based on a drawing. This example is a means to apply the electric gun of drawing 2 , in the system configuration of drawing 1 . Drawing 6 is the explanatory view of the instruction means of the work-piece contact location of the fixed side electrode tip, and the explanatory view and drawing 6 (b) to which drawing 6 (a) registers the criteria location (location of the gun motor 31) of the movable side electrode tip at the time of ****** are an explanatory view at the time of carrying out contact instruction, after setting up instruction symmetry work-piece conditions (thickness s, welding number of sheets t). Since the circuitry and each part actuation in drawing 1 and drawing 2 are described previously, the explanation is omitted.

[0014] Then, about the instruction means of the work-piece contact location of the fixed side electrode tip 37 in the control device of the robot for electric spot gun welding of this example, it is like this. First, the criteria location (location of the gun motor 31) p of the movable side electrode tip 36 at the time of ****** is registered like drawing 6 (a). Next, instruction symmetry work-piece conditions (thickness s, welding number of sheets t) are set up. And a robot is operated and positioning of the vertical direction of a gun is suitably taught to the location of the approach for welding. Next, the movable side electrode tip 36 is made to contact slowly like drawing 6 (b) by the contact executive state (contact torque detection condition of the gun motor 31). It is eta=(p-q)-(secondxt) when the 3rd amount eta of amendments which will carry out like drawing 6 within robot control equipment 15, and will carry out teaching if the location of contact is set to q is calculated here.
It becomes. And if contact instruction is specified and taught with this contact condition, the fixed side polar zone 35 will be taught where only the 3rd amount eta of amendments is amended (condition to which the fixed side electrode tip 37 contacted the work piece W). The check of a location can be performed by making it move to the location manually after instruction. Thus, it does not have the equalizing device of a gun from this example, and there is no need for the contact instruction to a work piece one by one for whenever [of welding / every], and it becomes advantageous in cost and efficiently.
[0015]
[Effect of the Invention] According to this invention, as explained above, under the environment which does not almost have a location gap of a work piece, an equalizing device and the sensor for wear detection are lost, management of a chip can be automated and effectiveness special [that it is possible to aim at schedule compaction of a design and enforcement and reduction of cost] can be done so from the location amendment of the electrode tip based on wear. Furthermore, since it becomes good, and the effectiveness on a design / enforcement can count also upon cost reduction and the fine management of the abnormalities in a transformer thermostat of it is attained from amelioration of the circuitry on wiring of this invention, it is effective in raising safety and workability. further -- again -- the equalizing device of this invention -- according to being unnecessary and the means without the contact instruction to a work piece moreover, the contact location of a fixed side electrode can be taught easily, and deletion of the expansion and cost of the degree of freedom of a gun design etc. can be expected by compaction of the instruction time amount of contact instruction, and the abbreviation of an equalizing device.

[Translation done.]

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CLAIMS

[Claim(s)]
[Claim 1] In the equipment which controls the robot which welds a weldment-ed by resistance by the electric spot gun A means to ****** with the electrode tip of criteria at the time of instruction, and a means to make a movable side electrode contact the anchorage used as criteria, A means to make said ****** and robot location at the time of contact, and a gun motor location memorize, A means to compute the amount of amendments which performs ****** with the electrode tip currently used at the time of program playback, is made to contact an anchorage again, and can be found with the difference of a location with the time of instruction from each abrasion loss and it of the movable side electrode tip and the fixed side electrode tip, The control unit of the robot for spot welding characterized by having a means to perform actuation which amends the location of said movable side electrode tip and the fixed side electrode tip in said amount of amendments.
[Claim 2] ****** at the time of instruction and the location A of said movable side electrode tip at this time is memorized. The approach location C which can contact a criteria anchorage in said movable side electrode tip Move and teach a robot and said movable side electrode tip is made to contact said criteria anchorage from said location C. The movement magnitude of the location of said gun motor of the difference alpha with the location D of said movable side electrode tip at this time is memorized. The same ****** and said criteria anchorage contact are taught to the program at the time of a chip dress or chip exchange. ****** taught at the time of program playback of a chip dress or chip exchange is reproduced. The difference delta of the location of said gun motor of the location B of said movable side electrode tip and the location A at the time of instruction is computed. This difference delta serves as the 1st ** (movable side + fixed side) abrasion loss, and the contact to said criteria anchorage similarly taught is reproduced. The difference beta of approach location C' and said location D is detected. delta: -- the 1st ** (movable side + fixed side) abrasion loss, i.e., amount of movable side amendments alpha:criteria length-of-stroke beta[of ** a 1st]:, -- the time of the 1st wear -- length-of-stroke gamma=beta-alpha: -- 1st movable side abrasion loss epsilon=delta-(beta-alpha): -- as the 1st fixed side abrasion loss of fixed side amendments, i.e., 1st amount The control approach of the robot for spot welding characterized by amending said movable side electrode tip in the 1st amount of movable side amendments shown by delta, and amending said fixed side electrode tip with the 1st fixed side abrasion loss shown by epsilon.
[Claim 3] A means to make said gun motor location of the location of said movable side electrode tip memorize in the state of the same pressurization as the time of welding at a criteria work piece in the case of instruction, or to make said gun motor location, plate pressure, and welding number of sheets of a location of ****** memorize, With the electrode currently used at the time of program playback, spot welding The 2nd abrasion loss which carried out and added each abrasion loss of said movable side electrode tip and said fixed side electrode tip from the location of said movable side electrode tip at this time is computed. From this, said 1st abrasion loss, and said 1st amount of amendments the 2nd amount of amendments of said movable side electrode tip and said fixed side electrode tip The control unit of the robot for spot welding according to claim 1 characterized by having a means to compute and

amending wear of said electrode tip between the calculation periods of said 1st amount of amendments based on said 2nd amount of amendments.
[Claim 4] What had registered the location of said movable side electrode tip in the state of pressurization beforehand in the location of said gun motor, Difference delta' with the location of said gun motor of the pressurization location under welding is computed this time. delta': -- the 2nd ** (movable side + fixed side) abrasion loss, i.e., amount of movable side amendments of ** 2nd epsilon', -- =epsilon+{(delta' - delta) /2}: -- from the 2nd fixed side abrasion loss of fixed side amendments, i.e., the 2nd amount 2nd amount of movable side amendments delta', and the 2nd amount of fixed side amendments -- epsilon' -- the control approach of the robot for spot welding according to claim 2 characterized by computing and amending at the time of program playback of welding actuation.
[Claim 5] The control unit of the robot for spot welding according to claim 1 characterized by outputting an alarm signal or carrying out automatic chip exchange when it has a means to memorize the use marginal abrasion loss of the movable side electrode tip and the fixed side electrode tip and said 1st abrasion loss exceeds the value of said use marginal abrasion loss.
[Claim 6] When said 2nd total abrasion loss exceeds the value adding said movable side electrode tip and said fixed side electrode tip of said use marginal abrasion loss set up beforehand [whether an alarm signal is outputted after ending welding and] Or the control unit of the robot for spot welding according to claim 1 characterized by computing said 1st abrasion loss of said movable side electrode tip and said fixed side electrode tip, and which chip judging whether it is a use limitation, and outputting an alarm signal or carrying out automatic chip exchange.
[Claim 7] The control unit of the robot for spot welding characterized by having a means to input the thermostat signal of the welding transformer of a spot gun, a means to suspend welding actuation with said signal, and a means to output an alarm, in the equipment which controls the robot which welds a weldment-ed by resistance by the spot gun.
[Claim 8] In the equipment which controls the robot which welds a weldment-ed by resistance by the gun motorised spot gun The board thickness of a work piece, a means to set up welding number of sheets, and a means to move said fixed side electrode to a welding location with a robot shaft at the time of instruction, A means to make said movable side electrode contact a work piece, and a means to compute the movement magnitude for making said fixed side chip contact from said gun motor location at the time of said contact, The control unit of the robot for spot welding characterized by having a means to compute and teach the location which said fixed side electrode is made to contact from this movement magnitude.
[Claim 9] The location p of said gun motor of the criteria location of said movable side electrode tip at the time of ****** is registered. Set up thickness s and the welding number of sheets t of the work-piece conditions for instruction, and a robot is operated. When teach positioning of the vertical direction of a gun to the location of the approach for welding, said movable side electrode tip is made to contact slowly in the state of contact torque detection of said gun motor of a contact executive state and the location of contact is set to q, it is the 3rd amount eta of amendments which carries out teaching eta=(p-q)-(secondxt)
The control approach of the robot for spot welding characterized by what it asks by carrying out and is taught with this contact condition.

[Translation done.]

* NOTICES *

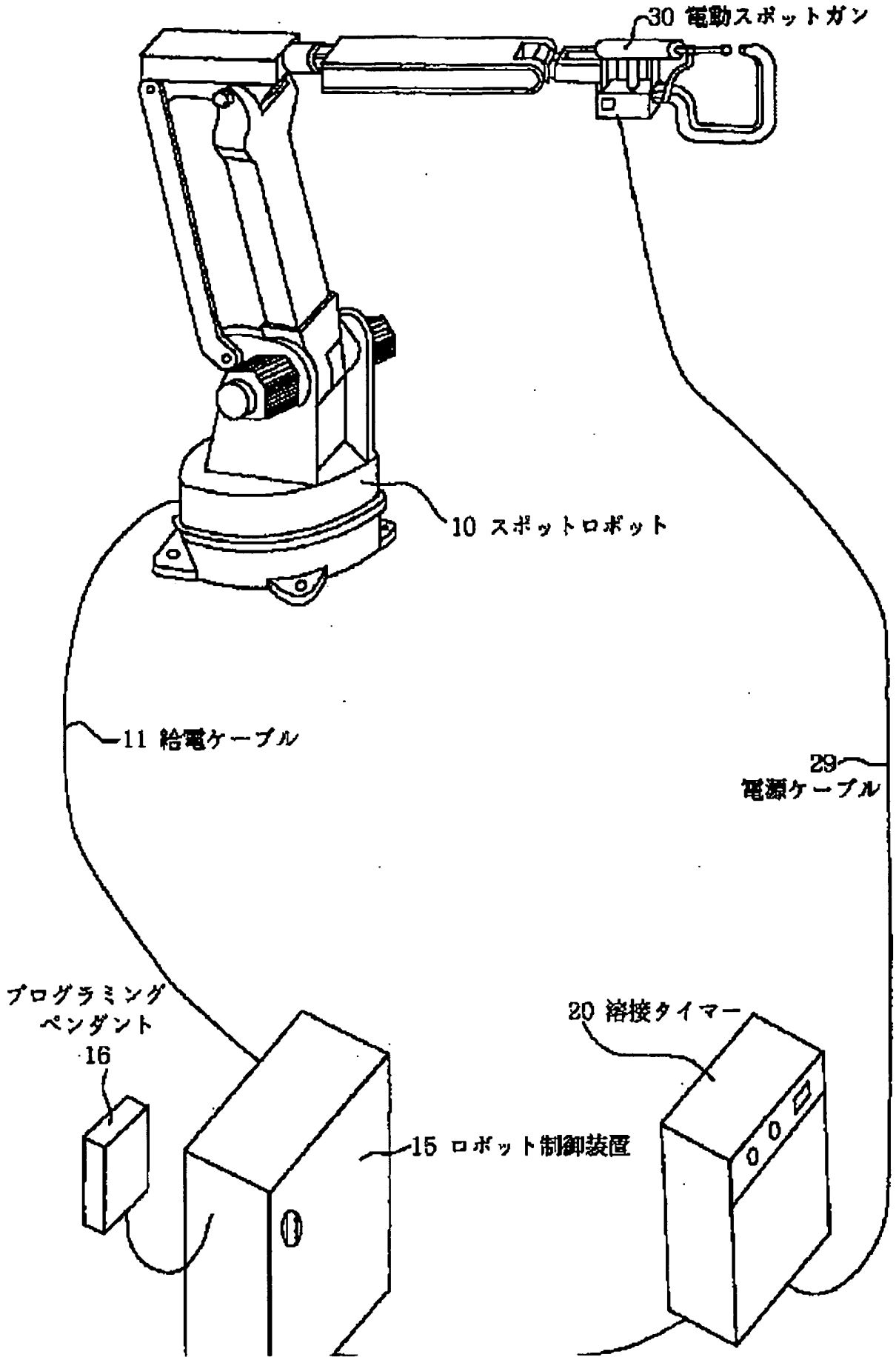
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

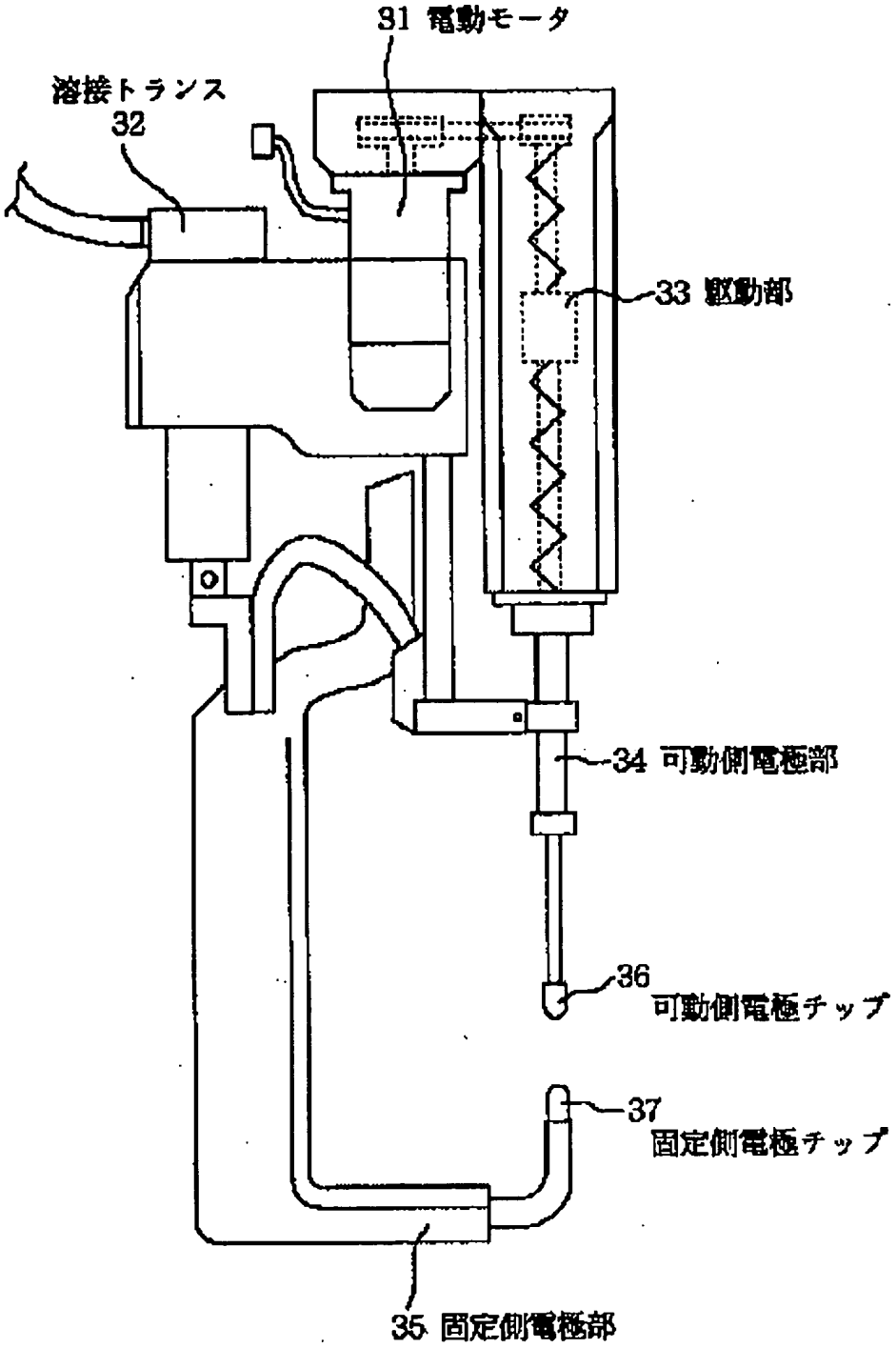
DESCRIPTION OF DRAWINGS

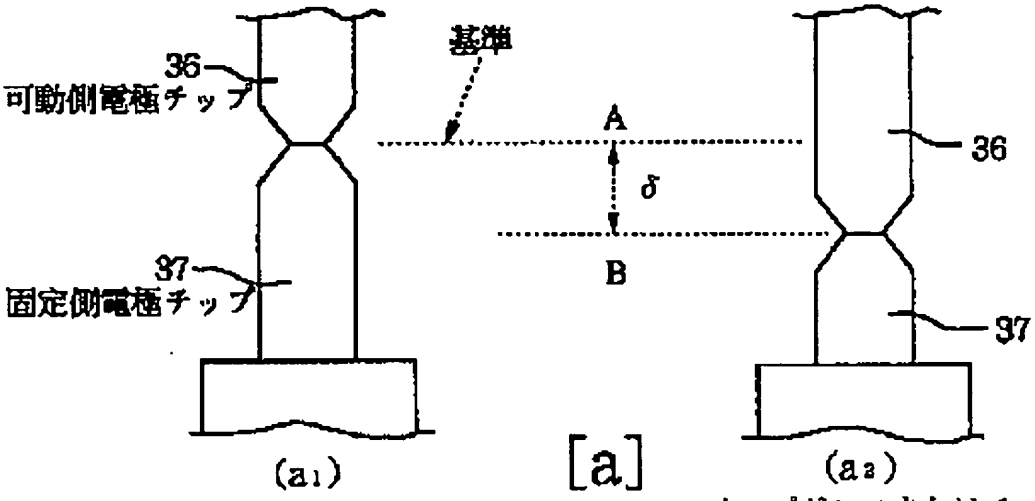
[Brief Description of the Drawings]
[Drawing 1] The notional perspective view showing an example of the system by which this invention is applied
[Drawing 2] the [of this invention] -- the electric spot gun in 1 and the 2nd-4th example is shown, the part is cut, and it is **** -- a side elevation
[Drawing 3] With the partial side elevation showing the configuration of the 1st example of this invention
(a) is a state diagram which ****** with the electrode tip of criteria at the time of instruction, registers and plays back a criteria location, and detects the 1st abrasion loss.
(b) is the state diagram which the robot was moved [state diagram] to the criteria anchorage, and the approach location which can contact the movable side electrode tip was taught [state diagram] to it, and made the movable side electrode tip contact a criteria anchorage from this location.
[Drawing 4] With the partial side elevation showing the configuration of the 2nd example of this invention
(a) is a state diagram which carries out teaching with the electrode tip of criteria at the time of instruction.
(b) is the state diagram made to contact to the real work piece in the time of played-back welding.
[Drawing 5] The notional perspective view showing the circuitry of the 3rd example of this invention
[Drawing 6] With the partial side elevation showing the configuration of the 4th example of this invention
(a) is a state diagram which registers the criteria location of the fixed side electrode tip of criteria at the time of instruction.
(b) is a state diagram at the time of setting up the work-piece conditions for instruction (thickness and welding number of sheets), and carrying out contact instruction.
[Drawing 7] The notional perspective view showing the example of a system in the conventional example
[Description of Notations]
10 Spot Robot
11 Electric Supply Cable (for Robot Drive Current Supply)
15 Robot Control Equipment
16 Programming Pendant (for Robots)
20 Welding Timer
21 Criteria Anchorage
22 Gun Control Signal Cable
23 Gun Control Signal Line
24 Transformer Thermostat Signal Line
25 Junction Section
28 Welding Control Signal

29 Power Cable
30 Electric Spot Gun (or Air Spot Gun)
31 Gun Motor
32 Welding Transformer
33 Mechanical Component
34 Movable Side Polar Zone
35 Fixed Side Polar Zone
36 Movable Side Electrode Tip
37 Fixed Side Electrode Tip

[Translation done.]

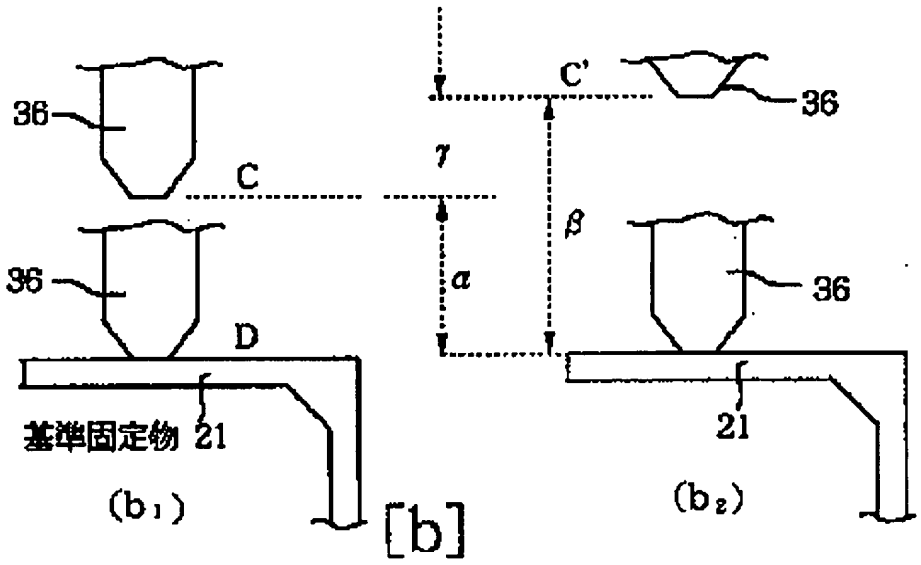

30 電動スポットガン
10 スポットロボット
11 給電ケーブル
29
電源ケーブル
プログラミング
ペンダント
16
20 溶接タイマー
15 ロボット制御装置

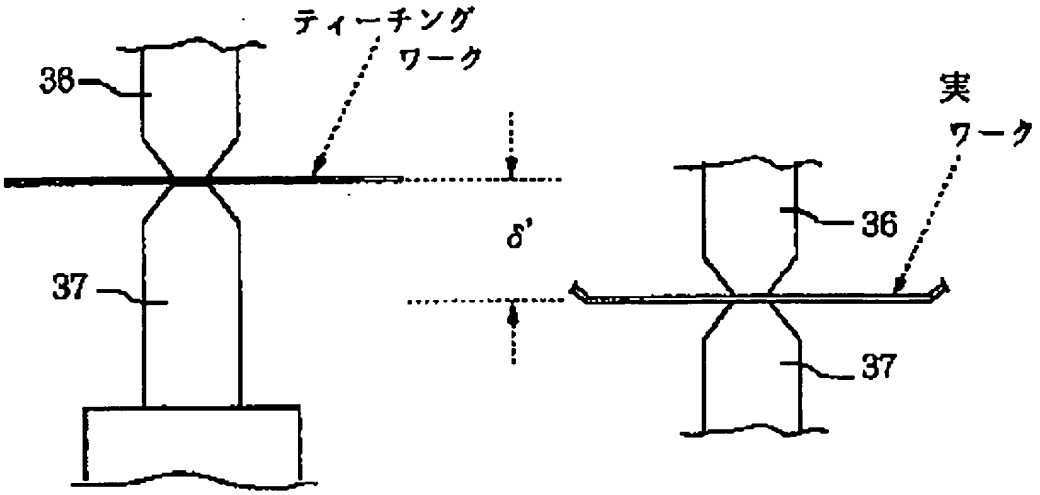

31 電動モータ
溶接トランス
32
33 駆動部
34 可動側電極部
36
可動側電極チップ
37
固定側電極チップ
35 固定側電極部



基準のチップで空打ち
上側チップ基準位置登録（ティーチング）

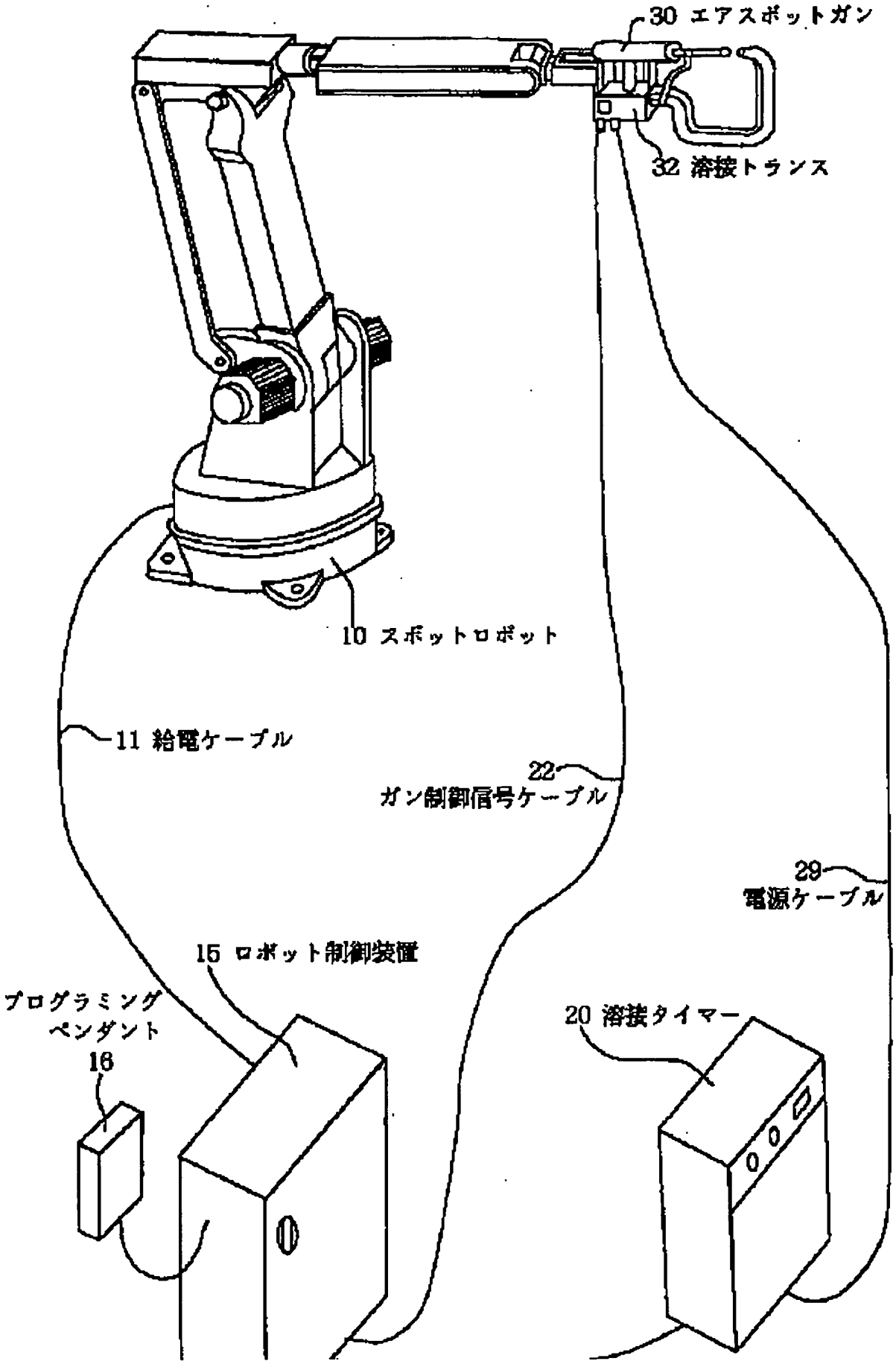
チップドレスまたはチップ交換時
（プレイバック）空打ち

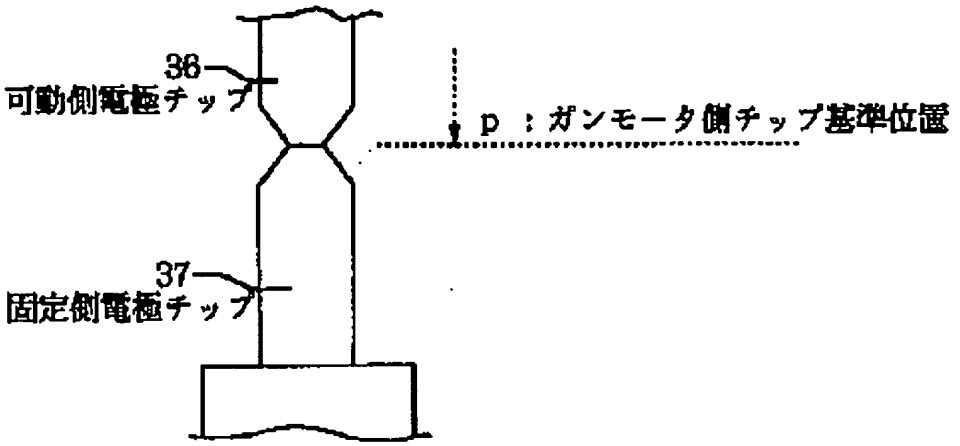




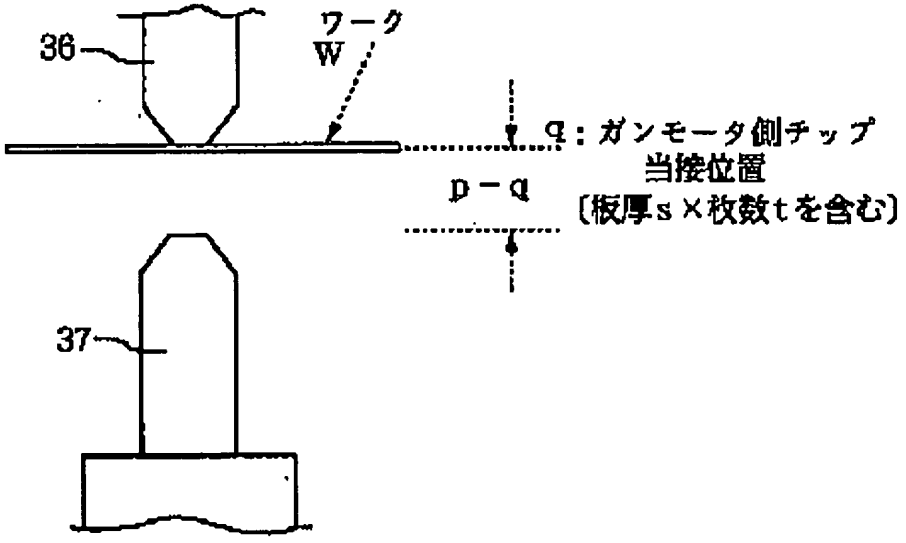
[a] [b]

基準のチップでティーチング　　プレイバックした後の溶接時

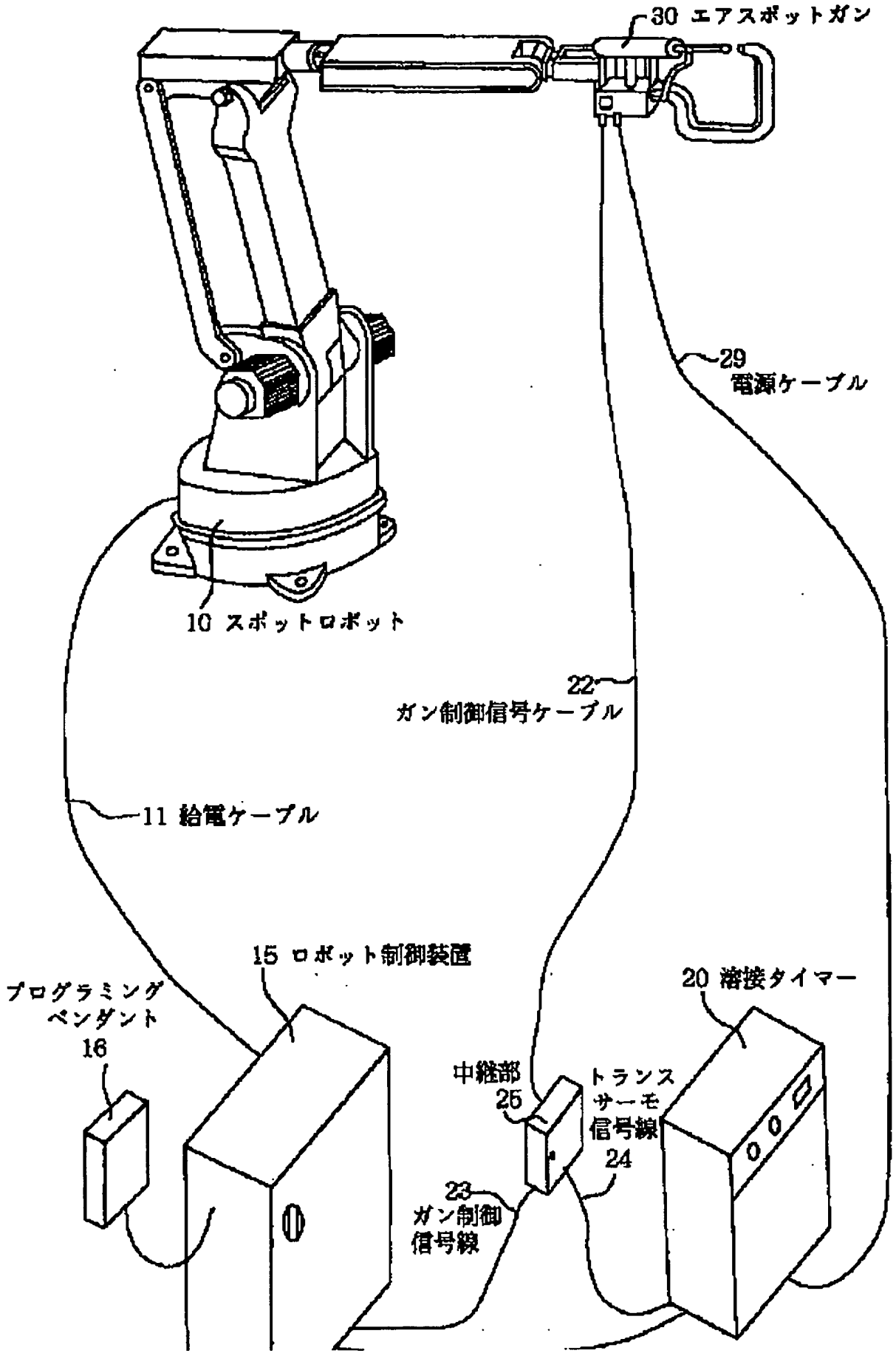

30 エアスポットガン
32 溶接トランス
10 スポットロボット
11 給電ケーブル
22
ガン制御信号ケーブル
29
電源ケーブル
15 ロボット制御装置
プログラミング
ペンダント
16
20 溶接タイマー


36
可動側電極チップ
p ：ガンモータ側チップ基準位置
37
固定側電極チップ

[a]


36
ワーク
W
q：ガンモータ側チップ
当接位置
〔板厚s×枚数tを含む〕
p－q
37

[b]


30 エアスポットガン
29
電源ケーブル
10 スポットロボット
22
ガン制御信号ケーブル
11 給電ケーブル
15 ロボット制御装置
プログラミング
ペンダント
16
20 溶接タイマー
中継部
25
トランス
サーモ
信号線
24
23
ガン制御
信号線

(19)日本国特許庁（ＪＰ）　(12)公開特許公報（Ａ）　(11)特許出願公開番号

特開平9－70675

(43)公開日　平成９年(1997)３月18日

(51)Int.Cl.⁶	識別記号	庁内整理番号	ＦＩ		技術表示箇所
Ｂ２３Ｋ　11/24	３４０		Ｂ２３Ｋ　11/24	３４０	
	３３６			３３６	
11/11	５７０		11/11	５７０Ｚ	
Ｂ２５Ｊ　9/22			Ｂ２５Ｊ　9/22	Ｚ	

審査請求　未請求　請求項の数９　ＦＤ　（全９頁）

(21)出願番号　特願平7－255517

(22)出願日　平成７年(1995)９月６日

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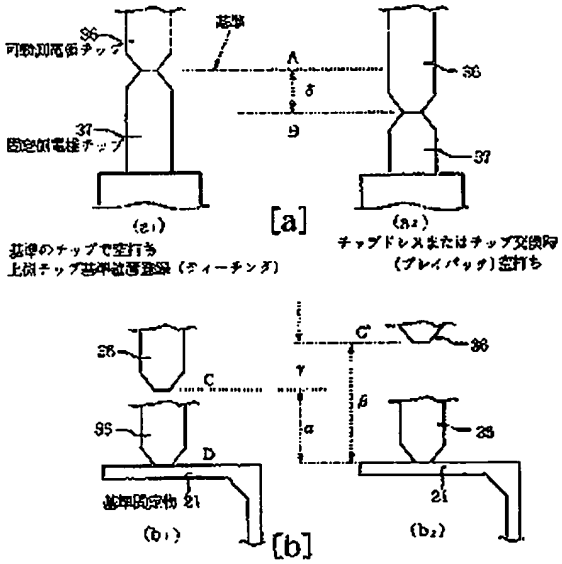
最終頁に続く

(54)【発明の名称】　スポット溶接用ロボットの制御装置とその制御方法

(57)【要約】

【目的】　ガンが加圧中にイコライズすることでロボット及びワークの衝撃と電極磨耗量を吸収し溶接しているが、イコライズ機構をなくし溶接チップ管理の自動化も可能にする。

【構成】　教示時に基準の電極チップで空打ちする手段と、可動側電極を基準となる固定物に当接させる手段と、前記空打ちした当接時のロボット位置とガンモータ位置を記憶させる手段と、プログラム再生時に使用している電極チップで空打ちしまた固定物に当接させ教示時との位置の差で可動側電極チップの磨耗量・補正量を算出する手段と、前記補正量で可動側電極チップの位置を補正し動作する手段を有して成る。



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【特許請求の範囲】

【請求項１】　電動スポットガンで被溶接物を抵抗溶接するロボットを制御する装置において．教示時に基準の電極チップで空打ちする手段と、可動側電極を基準となる固定物に当接させる手段と、前記空打ちと当接時のロボット位置とガンモータ位置を記憶させる手段と．プログラム再生時に使用している電極チップで空打ちを行いまた固定物に当接させ教示時との位置の差で可動側電極チップ，固定側電極チップのそれぞれの摩耗量及びそれから求まる補正量を算出する手段と．前記補正量で前記可動側電極チップ及び固定側電極チップの位置を補正する動作を行う手段を有することを特徴とするスポット溶接用ロボットの制御装置。

【請求項２】　教示時に空打ちし、この時の前記可動側電極チップの位置Ａを記憶し、基準固定物に前記可動側電極チップを当接出来るアプローチ位置Ｃを、ロボットを動かして教示し、前記位置Ｃから前記可動側電極チップを前記基準固定物に当接させ、この時の前記可動側電極チップの位置Ｄとの差αの前記ガンモータの位置の移動量を記憶し．同じ空打ちと前記基準固定物当接をチップドレスあるいはチップ交換時のプログラムに教示しておき．チップドレスまたはチップ交換のプログラム再生時に教示しておいた空打ちを再生し．前記可動側電極チップの位置Ｂの前記ガンモータの位置と教示時の位置Ａとの差δを算出し、この差δは第１の全（可動側＋固定側）摩耗量となり、同じく教示しておいた前記基準固定物への当接を再生し、アプローチ位置Ｃ´と前記位置Ｄの差βを検出し．

δ：第１の全（可動側＋固定側）摩耗量すなわち第１の可動側補正量

α：基準ストローク長さ

β：第１の摩耗時ストローク長さ

γ＝β－α：第１の可動側摩耗量

ε＝δ－（β－α）：第１の固定側摩耗量すなわち第１の固定側補正量

として、δにて示された第１の可動側補正量で前記可動側電極チップを補正し、εにて示された第１の固定側摩耗量で前記固定側電極チップを補正することを特徴とするスポット溶接用ロボットの制御方法。

【請求項３】　教示の際に基準ワークで溶接時と同じ加圧状態で前記可動側電極チップの位置の前記ガンモータ位置を記憶させるかまたは空打ちの位置の前記ガンモータ位置と板圧と溶接枚数を記憶させる手段と、プログラム再生時に使用している電極でスポット溶接を行いこの時の前記可動側電極チップの位置より前記可動側電極チップと前記固定側電極チップのそれぞれの摩耗量を加算した第２の摩耗量を算出しこれと前記第１の摩耗量，前記第１の補正量より前記可動側電極チップ，前記固定側電極チップの第２の補正量を算出する手段を有し．前記第１の補正量の算出周期の間に、前記第２の補正量に基づき前記電極チップの摩耗を補正することを特徴とする請求項１記載のスポット溶接用ロボットの制御装置。

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【請求項４】　予め加圧状態で前記可動側電極チップの位置を前記ガンモータの位置で登録していたものと、今回溶接中の加圧位置の前記ガンモータの位置との差δ´を算出して、

δ´：第２の全（可動側＋固定側）摩耗量すなわち第２の可動側補正量

ε´＝ε＋｛（δ´－δ）／２｝：第２の固定側摩耗量すなわち第２の固定側補正量から、第２の可動側補正量δ´及び第２の固定側補正量をε´算出して、溶接動作のプログラム再生時に補正を行うことを特徴とする請求項２記載のスポット溶接用ロボットの制御方法。

【請求項５】　可動側電極チップ及び固定側電極チップの使用限界摩耗量を記憶する手段を有し、前記第１の摩耗量が前記使用限界摩耗量の値を越えたときに．警報信号を出力したり自動チップ交換をすることを特徴とする請求項１記載のスポット溶接用ロボットの制御装置。

【請求項６】　前記第２の全摩耗量が予め設定した前記使用限界摩耗量の前記可動側電極チップと前記固定側電極チップを加算した値を越えたときに．溶接を終了後、警報信号を出力するか、または、前記可動側電極チップ及び前記固定側電極チップの前記第１の摩耗量を算出し．どちらのチップが使用限界かを判断して警報信号を出力したり自動チップ交換をすることを特徴とする請求項１記載のスポット溶接用ロボットの制御装置。

【請求項７】　スポットガンで被溶接物を抵抗溶接するロボットを制御する装置において、スポットガンの溶接トランスのサーモスタット信号を入力する手段と．前記信号により溶接動作を停止する手段と．警報を出力する手段を有することを特徴とするスポット溶接用ロボットの制御装置。

【請求項８】　ガンモータ駆動のスポットガンで被溶接物を抵抗溶接するロボットを制御する装置において、ワークの板厚と溶接枚数を設定する手段と、教示時に前記固定側電極をロボット手で溶接位置に移動する手段と、前記可動側電極をワークに当接させる手段と、前記当接時の前記ガンモータ位置より前記固定側チップを当接させるための移動量を算出する手段と．この移動量より前記固定側電極を当接させる位置を算出し教示する手段を備えることを特徴とするスポット溶接用ロボットの制御装置。

【請求項９】　空打ち時の前記可動側電極チップの基準位置の前記ガンモータの位置ｐを登録し、教示対象ワーク条件の厚みｓ・溶接枚数ｔを設定し．ロボットを動作させ．溶接のためのアプローチの位置にガンの上下方向の位置決めを教示し、前記可動側電極チップを当接監視状態の前記ガンモータの当接トルク検出状態でゆっくりと当接させ、当接の位置をｑとすると．ティーチングする第３の補正量ｒを

$\eta = (p - q) - (s \times t)$

として求め、この当接状態のままで教示することを特徴とするスポット溶接用ロボットの制御方法。

【発明の詳細な説明】

【０００１】

【産業上の利用分野】本発明は、スポット溶接用ロボットの制御装置とその制御方法に関する。

【０００２】

【従来の技術】従来、ロボットでのスポット溶接では溶接用スポットガンが加圧中にイコライズ(equalize)することで、ロボット及びワークの衝撃と電極摩耗量を吸収し、溶接していた［以下、これを「従来例１」という］。また、摩耗検出の方策も例えば特公平6-79787 や実公平6-27273 の様に、ガンや外部に専用のセンサを設け検出する手段［以下、これらを「従来例２および従来例３」という］であった。さらに、チップ交換に関しては、溶接をした回数で成形し、成形回数で交換するか、従来例２および従来例３の前記センサより得られた検出量によっていた［以下、これを「従来例４」という］。そして、トランスサーモ異常の処理手段としては図７に示すそのシステム例の様に、ガンの溶接トランスのサーモスタット信号線は溶接タイマーに配置され、運転中にトランスのサーモ異常を溶接タイマーが検出すれば、これを溶接異常として他の要因と統合され、ロボット制御装置に出力し、ロボットとしては溶接異常アラームとして処理していた。すなわち従来例の配線例としてのは図７において、スポットロボット１０はスポットガン３０を装着し、スポットガン３０からはロボット制御装置１５へ、ガン制御ケーブル２２が中継部２５を介して、ガン制御信号線２３として配線され、一方トランスサーモ信号線２４として、中継部２５を介して溶接タイマー２０へ配線される。溶接タイマー２０へはロボット制御装置１５より、溶接信号線２８が接続され、かつスポットガン３０のトランス３２への電源ケーブル２９で接続されている。なお、１１はスポットロボット１０を姿勢制御する駆動モータへの電源供給用の給電ケーブル、１６はロボット用のプログラミングペンダント(programming pendant) である［以下、これを「従来例５」という］。さらにまた、従来のロボットの電動スポットガン溶接では、固定側電極をワークに当接させてその位置を教示する必要があり、この教示をする場合、固定側電極を微少量づつ移動させワークに当接させ教示するか、ガンにイコライズ機構を有し、ロボットの教示としてはワークへの当接教示をしなくても溶接出来る様にしていた［以下、これを「従来例６」という］。ここで、イコライズ機構について少しく付言すれば、溶接ガンを加圧方向に変位可能に支持するもので、被溶接物の位置ずれを吸収するようにした手段であり、例えば移動側電極の加圧動作で移動側電極がワークに当接したときに、固定側電極の固定ロックが解け、固定側電極がバネ手段により揺動可能な状態になり、被溶接物の位置ずれを無くすように、固定側電極が先の揺動に基づき被溶接物に当接する機構である。ところで、先に掲記した文献による先行技術を敷衍すれば、従来例２は、溶接ガンをロボットによりワークの複数の打点位置に順次移動して溶接を行う自動溶接機において、正規の寸法の新品の電極チップを取付けた状態で溶接ガンを空打ちしたときのガンアームの開度を基準開度として、電極チップの長さが使用限界まで減少したときのガンアームの下限開度を設定し、ワークの最初の打点位置の溶接を行う前に溶接ガンを空打ちして、このときのガンアームの開度を溶接ガンに設けた開度センサにより検出し、この検出開度と前記下限開度を比較して、電極チップの交換の必要性の有無を判別すると共に、前記基準開度に許容誤差を加えた上限開度を設定し、前記検出開度が該上限開度を上廻ったとき、チップ不良を示す表示器を作動するようにしたことを特徴とする自動溶接機における溶接ガンの電極チップ管理方法である。なお、従来例３は、ロボット本体のアームにイコライザを介して溶接ユニットを浮動支持させた溶接ロボット装置において、上記アームに対する溶接ユニットの位置を電極対向方向に変位させる電極位置補正装置と、溶接ユニットの固定電極の摩耗量を検出する摩耗量検出装置と、この摩耗量検出装置により検出した電極摩耗量に基づいて上記摩耗量検出装置をアームに対する固定電極の位置を初期位置に補正するように作動させる制御装置とを備えていることを特徴とする溶接ロボット装置である。

【０００３】

【発明が解決しようとする課題】ところが、従来例１ないし従来例４のイコライズ機構はガン設計の自由さを制限し、センサは溶接環境から施行が難しい等の他、両者共コストアップの一因となっていた。そこで、本発明は、イコライズ機構やセンサ等を用いずにチップの摩耗量を検出し、摩耗量補正及びチップ交換時期を検出することが可能なスポット溶接用ロボットの制御装置とその方法を提供することを第１の目的とする。さらに、従来例５の方法では、ストロークの異なるガンが登場し、スポットガンの制御はロボット制御装置でするようになった昨今では、溶接トランスのサーモスタット出力信号を伝送するラインだけが、ガンから溶接機に配線することになり、設計、施行上の効率が悪い。また、ロボット制御装置としては、トランスサーモ異常の個別要因として取れるはずの異常を、溶接異常として統合した形でしかとれないので、細かな対処がしがたいという問題点があった。そこで、本発明は、スポットガンのサーモスタット信号を直接配線するように、この信号の監視・処理手段を持ったスポット溶接用ロボットの制御装置を提供することを第２の目的とする。さらにまた、従来例６に見られるスポット溶接用ロボットにおける教示方法では、固定側電極をワークへ当接させる教示が困難であり、時

間も掛かるなどの問題点があり、また、イコライズ機構は、コストアップの一因となっていた。そこで、本発明は、簡単な方法で、固定側電極の当接位置を教示できるスポット溶接用ロボットの制御装置とその方法を提供することを第3の目的とする。

【0004】

【課題を解決するための手段】上記課題を解決するために、本発明は、電動スポットガンで被溶接物を抵抗溶接するロボット制御装置において、イコライズ機構やセンサ等を用いずに、電動スポットガンの駆動時の到達位置より、チップの摩耗量を検出し、摩耗量補正及びチップ交換時の検出をするスポット溶接用ロボット制御装置であり、またスポットガンの溶接トランスのサーモスタット信号の監視・処理手段を持つスポット溶接用ロボット制御装置であり、さらに被溶接物を抵抗溶接するロボットにおいて、簡単な手段で、固定側電極の当接位置を教示できるスポット溶接用ロボット制御装置である。すなわち、電動スポットガンで被溶接物を抵抗溶接するロボットを制御する装置において、教示時に基準の電極チップで空打ちする手段と、可動側電極を基準となる固定物に当接させる手段と、前記空打ちと当接時のロボット位置とガンモータ位置を記憶させる手段と、プログラム再生時に使用している電極チップで空打ちを行いまた固定物に当接させ教示時との位置の差で可動側電極チップ，固定側電極チップのそれぞれの摩耗量及びそれから求まる補正量を算出する手段と、前記補正量で前記可動側電極チップ及び固定側電極チップの位置を補正する動作を行う手段を有するスポット溶接用ロボットの制御装置であり、また教示時に空打ちし、この時の前記可動側電極チップの位置Aを記憶し、基準固定物に可動側電極チップを当接出来るアプローチ位置Cを、ロボットを動かして教示し、位置Cから可動側電極チップを基準固定物に当接させ、この時の可動側電極チップの位置Dとの差αのガンモータの位置の移動量を記憶し、同じ空打ちと基準固定物当接をチップドレスあるいはチップ交換時のプログラムに教示しておき、チップドレスまたはチップ交換のプログラム再生時に教示しておいた空打ちを再生し、可動側電極チップの位置Bのガンモータの位置と教示時の位置Aとの差δを算出し、この差δは第1の全（可動側＋固定側）摩耗量となり、同じく教示しておいた基準固定物への当接を再生し、アプローチ位置C´と位置Dの差βを検出し、

δ：第1の全（可動側＋固定側）摩耗量すなわち第1の可動側補正量

α：基準ストローク長さ

β：第1の摩耗時ストローク長さ

γ＝β－α：第1の可動側摩耗量

ε＝δ－（β－α）：第1の固定側摩耗量すなわち第1の固定側補正量

として、δにて示された第1の可動側補正量で可動側電極チップを補正し、εにて示された第1の固定側摩耗量で前記固定側電極チップを補正するスポット溶接用ロボットの制御方法であり、さらに教示の際に基準ワークで溶接時と同じ加圧状態で可動側電極チップの位置のガンモータ位置を記憶させるかまたは空打ちの位置のガンモータ位置と板厚と溶接枚数を記憶させる手段と、プログラム再生時に使用している電極でスポット溶接を行いこの時の可動側電極チップの位置より可動側電極チップと固定側電極チップのそれぞれの摩耗量を加算した第2の摩耗量を算出しこれと第1の摩耗量、第1の補正量より可動側電極チップ，固定側電極チップの第2の補正量を算出する手段を有し、第1の補正量の算出周期の間に、第2の補正量に基づき電極チップの摩耗を補正する第1項に記載のスポット溶接用ロボットの制御装置であり、さらにまた予め加圧状態で可動側電極チップの位置をガンモータの位置で登録していたものと、今回溶接中の加圧位置のガンモータの位置との差δ´を算出して、

δ´：第2の全（可動側＋固定側）摩耗量すなわち第2の可動側補正量

ε´＝ε＋｛（δ´－δ）／2｝：第2の固定側摩耗量すなわち第2の固定側補正量から、第2の可動側補正量δ´及び第2の固定側補正量をε´算出して、溶接動作のプログラム再生時に補正を行う第2項に記載のスポット溶接用ロボットの制御方法であり、なお可動側電極チップ及び固定側電極チップの使用限界摩耗量を記憶する手段を有し、第1の摩耗量が使用限界摩耗量の値を越えたときに、アラーム信号を出力したり、自動チップ交換をする第1項に記載のスポット溶接用ロボットの制御装置であり、なおかつ第2の全摩耗量が予め設定した使用限界摩耗量の可動側電極チップと固定側電極チップを加算した値を越えたときに、溶接を終了後、警報信号を出力するか、または、可動側電極チップ及び固定側電極チップの第1の摩耗量を算出し、どちらのチップが使用限界かを判断して警報信号を出力したり自動チップ交換をする第1項に記載のスポット溶接用ロボットの制御装置であり、しかもスポットガンで被溶接物を抵抗溶接するロボットを制御する装置において、スポットガンの溶接トランスのサーモスタット信号を入力する手段と、その信号により溶接動作を停止する手段と、警報を出力する手段を有するスポット溶接用ロボットの制御装置であり、しかもなおガンモータ駆動のスポットガンで被溶接物を抵抗溶接するロボットを制御する装置において、ワークの板厚と溶接枚数を設定する手段と、教示時に固定側電極をロボット腕で溶接位置に移動する手段と、可動側電極をワークに当接させる手段と、当接時の前記ガンモータ位置より固定側チップを当接させるための移動量を算出する手段と、この移動量より固定側電極を当接させる位置を算出し教示する手段を備えるスポット溶接用ロボットの制御装置であり、そしてまた空打ち時の可動側電極チップの基準位置のガンモータの位置pを登録

し．教示対象ワーク条件の厚みｓ・溶接枚数ｔを設定し．ロボットを動作させ．溶接のためのアプローチの位置にガンの上下方向の位置決めを教示し、可動側電極チップを当接監視状態のガンモータの当接トルク検出状態でゆっくりと当接させ、当接の位置をｑとすると．ティーチングする第３の補正量ηを

η＝（ｐ－ｑ）－（ｓ×ｔ）

として求め、この当接状態のままで教示するスポット溶接用ロボットの制御方法である。

【０００５】

【作用】上記手段により．本発明は．ワークの位置ずれが殆どない環境では、イコライズ機構やセンサをなくすことが出来、設計，施行の簡易化、日程短縮やコストの低減を図ることができる。上記手段により、本発明は、ガンの加圧信号．ストローク切換信号．開放確認信号およびトランスのサーモスタット信号を含めてスポットガンに関わる全ては、ロボット制御装置にのみ配線できるので．設計・施行上の効率が良くなり．コスト削減も見込める。また．スポットガンのトランスのサーモスタット信号を直接ロボット制御装置に配線することにより、溶接異常として統合した形でなく、トランスのサーモスタット異常として別個に認識でき、細かな対処が可能となり．安全性や作業効率も向上する。上記手段により、固定側電極の当接位置を簡単に教示でき、イコライズ機構の無いガンでは当接教示の教示時間の短縮、イコライズ機構付きのガンでは摩耗補正との併用で、イコライズ機構の省略でガン設計の自由度の拡大．コストの削減などを見込むことが出来る。

【０００６】

【実施例】以下．本発明の各実施例を図面に基づいて説明する。なお．各図面において、同一符号は同一もしくは相当部材を表す。図１は本発明が適用されるシステムの一例を表す概念的斜視図．図２は本発明の第１の実施例における電動スポットガンを示す側面図である。図１．図２において、スポットロボット１０は電動スポットガン３０を装着し、溶接タイマー２０へはロボット制御装置１５より溶接制御信号線２８と．電動スポットガン３０の溶接用トランス３２より電源ケーブル（溶接用）２９が接続されている。また、電動スポットガン３０の電動モータ３１の制御はロボット制御装置１５で行い．電動モータ３１を駆動するボールネジなどから成る駆動部３３を介し、可動側電極部３４の先端の可動側電極チップ３６が．ワーク（不図示）への加圧，開放の動作をする。さらにまた、固定側電極部３５の先端の固定側電極チップ３７は溶接トランス３２より、可動側電極チップ３６と共に溶接時の大電流を得ている。そして、図３は本発明の第１の実施例の構成を示す部分側面図、図４は本発明の第２の実施例の構成を表す部分側面図である。ここに．本システムでのチップ交換時期の検出及び摩耗量補正は次のようになる。

【０００７】［電動スポットガンのチップドレス（チップ研磨）またはチップ交換時に行う補正］初めに、本発明の第１の実施例として．チップドレスまたはチップ交換時に行う第１の補正について、以下に説明する。図３はチップドレスまたはチップ交換時に行う補正の説明図である。まず．図３（ａ１）の様に教示の際に．基準の電極チップで空打ちをする。この際の可動側電極チップ３６の位置Ａ（ガンモータ３１の位置）を記憶する。つまり、基準のチップで空打ちし（上側）可動側電極チップ３６の基準位置Ａを登録する。また、図３（ｂ１）の様に，基準固定物２１に可動側電極チップ３６を当接出来るアプローチ位置Ｃを．ロボットを動かして教示し．このアプローチ位置Ｃから可動側電極チップ３６を基準固定物２１に当接させ．この時の可動側電極チップ３６の位置Ｄとの差α（ガンモータ３１の位置の移動量）を記憶する。この時．同じ空打ちと基準固定物当接をチップドレスやチップ交換時のプログラムに教示しておく。

【０００８】　次に、図３（ａ２）の様に，チップドレスやチップ交換のプログラム再生時に教示しておいた空打ちを再生し．可動側電極チップ３６の位置Ｂ（ガンモータ３１の位置）と教示時の位置Ａとの差δを算出する。この差δは第１の全（可動側＋固定側）摩耗量となる。それから．同じく教示しておいた基準固定物２１への当接を再生し．アプローチ位置Ｃ’（可動チップの摩耗分だけＣよりずれた位置．ガンモータ３１の位置はＣと同じ位置）と可動側電極チップ３６の位置Ｄ（ガンモータ３１の位置ではＤ＋可動チップ摩耗量）の差βを検出する。これにより、

δ：第１の全（可動側＋固定側）摩耗量すなわち第１の可動側補正量

α：基準ストローク長さ

β：第１の摩耗時ストローク長さ

γ＝β－α：第１の可動側摩耗量

ε＝δ－（β－α）：第１の固定側摩耗量すなわち第１の固定側補正量

となる。

【０００９】　ここで、δが第１の可動側補正量となるのは．固定側電極チップ３７を第１の固定側補正量だけ可動側方向に補正すると．そのままでは、可動側電極チップ３６もそれだけ動く［図２の機構参照］ので．逆方向に同量だけ補正する必要がある。このように．本発明は．基本的には次の考え方から成り立つ。すなわち

固定側摩耗量＝固定側摩耗量

固定側摩耗量＋可動側摩耗量＝可動側補正量

という関係が成立する。これを具体的に説明すると、可動側電極チップ３６の摩耗量は電動スポットガン３０のサーボ位置補正で行われ［その時、後述するスポットロボット１０の位置補正を相殺する］．固定側電極チップ３７の摩耗量はスポットロボット１０の位置を補正する

ことになる。

【００１０】　［電動スポットガンの溶接動作のプログラム再生時の教示の際に行う補正］次いで、本発明の第２の実施例として、溶接動作のプログラム再生時に、教示の際に行う第２の補正について説明する。この第２の補正をするように設定した位置（通常は溶接するためのアプローチの位置）について、第１の可動補正量δと第１の固定側補正量εを、さらなる補正を行った後に各電極を動作させる。先に述べたチップドレスまたはチップ交換時の補正は、これだけでも十分に使えるが、溶接動作のプログラム再生時の教示の際に補正を行うと、さらなる溶接精度が得られる。すなわち、この場合教示動作の際に、溶接時に補正量算出をする設定になっているとする。予め加圧状態で可動側電極チップ３６の位置（ガンモータ３１の位置）を取っていたものと、今回溶接中の加圧位置（ガンモータ３１の位置）の差δ′を算出し、以下の式より第２の可動側補正量、第２の固定側補正量を算出する。

δ′：第２の全（可動側＋固定側）摩耗量すなわち第２の可動側補正量

ε′＝ε＋｛（δ′－δ）／２｝：第２の固定側摩耗量すなわち第２の固定側補正量

これは、前述のチップドレスやチップ交換時の第１の補正を使用した場合、前回のチップドレスやチップ交換時の補正から現在までの第３の全摩耗量（δ′－δ）より可動側電極チップ３６，固定側電極チップ３７が均等に摩耗したと仮定し補正するものである。

【００１１】　また、チップドレスやチップ交換時の第１の補正を使用していないときは、第１の固定側摩耗量・第１の固定側補正量ε＝０、第１の全（可動側＋固定側）摩耗量・第１の可動側補正量δ＝０として計算すれば、簡易的な補正手段として、溶接時の第２の補正だけでも使用できる。第２の補正動作のさせ方は、第１のチップドレスやチップ交換時の補正の時と同様である。また、スポット溶接時に算出した第２の全摩耗量δ′が予め記憶させた可動側電極チップ３６及び固定側電極チップ３７の使用限界摩耗量を加算した値を超えていれば、チップドレスまたはチップ交換時の補正と同じ手順で、可動側電極チップ３６及び固定側電極チップ３７の第１の摩耗量を算出し、どちらの電極チップが使用限界かを判断し、その時点で電極チップ交換位置にロボットが退避し、交換要求信号を出力したり、自動で自動チップ交換をするプログラムを実行することも可能である。以上のようにチップの摩耗量検出と補正機能を適時、周期的にすれば、チップの管理を自動化することも可能となる。また、チップドレスやチップ交換時の補正と溶接時の補正を併用すれば、より適切な補正が可能となる。

【００１２】　［エアスポットガン溶接用ロボットの制御装置における制御配線手段］図５は、本発明の第３の実施例の配線並びにその回路構成を表す概念図である。なお、本実施例ではエアスポットガン３０を使用しているが、電動スポットガン３０を適用され得ることは言うまでもない。ここに提示した本実施例では図５に示すように、エア［または電動］スポットガン３０からのガン制御ケーブル２２が中継部２５を経由しないで、直接、ロボット制御装置１５へ接続され、トランスサーモ信号を含め全ての信号が伝送されるように配線されている。すなわち、従来例の図７ではエアスポットガン３０より溶接機２０に、ただ１本配線されていたエアスポットガン３０のトランスサーモ信号線２４が、本実施例の図５では、他のガン制御信号ケーブルに関わる信号と共に、ガン制御ケーブル２２より直接、ロボット制御装置１５へ配線され、エアスポットガン３０から溶接機２０に配線されるものは無くなり、効率的である。また、これまで溶接異常として認められていたため、ロボット側が停止してその原因について溶接機を調べていたのを、その理由がトランスサーモ異常と分かることで、ロボットを操作し易く安全な姿勢・場所に戻した上で、アラームとする等の処理が出来るようになり、溶接機を調べる手も無くなる。

【００１３】　［電動スポットガン溶接用ロボットの制御装置での固定側電極チップのワーク当接位置の教示手段］本発明の第４の実施例として、イコライズ機構を持たず、溶接毎に教示なしで複数枚のワークを、時宜に適した固定側電極補正がなされる手段を掲記する。以下、本実施例を図面に基づいて説明する。本実施例は、図１のシステム構成において、図２の電動ガンを適用する手段である。図６は、固定側電極チップのワーク当接位置の教示手段の説明図で、図６（ａ）は空打ち時に可動側電極チップの基準位置（ガンモータ３１の位置）を登録する説明図・図６（ｂ）は教示対称ワーク条件（厚みｓ，溶接枚数ｔ）を設定した後に当接教示する際の説明図である。図１、図２における回路構成・各部動作は先に述べているから、その説明は省く。

【００１４】　そこで、本実施例の電動スポットガン溶接用ロボットの制御装置での固定側電極チップ３７のワーク当接位置の教示手段については、こうである。先ず、図６（ａ）の様に、空打ち時の可動側電極チップ３６の基準位置（ガンモータ３１の位置）ｐを登録する。次に、教示対称ワーク条件（厚みｓ，溶接枚数ｔ）を設定する。それから、ロボットを動作させ溶接のためのアプローチの位置にガンの上下方向の位置決めは適当に教示する。次に、図６（ｂ）の様に、可動側電極チップ３６を当接監視状態（ガンモータ３１の当接トルク検出状態）でゆっくりと当接させる。ここで、当接の位置をｑとすると、ロボット制御装置１５内で図６のようにして、ティーチングする第３の補正量ηを求めると

η＝（ｐ－ｑ）－（ｓ×ｔ）

となる。そして、この当接状態のまま当接教示を指定し、教示すると、固定側電極部３５が第３の補正量ηだ

け補正された状態（固定側電極チップ37がワークWに当接した状態）で教示される。位置の確認は教示後、その位置に手動で移動させることで出来る。このようにして、本実施例からガンのイコライズ機構を備えず、かつ溶接の度毎に一々ワークへの当接教示の必要がなくて、コスト的にも効率的に有利となる。

【0015】

【発明の効果】以上説明したように、本発明によれば、ワークの位置ずれが殆どない環境下では、イコライズ機構や摩耗検出用センサをなくし、摩耗に基づく電極チップの位置補正から、チップの管理を自動化することが出来、設計・施行の日程短縮やコストの低減を図ることが可能という特段の効果を奏することができる。さらに、本発明の配線上の回路構成の改良から、設計・施行上の効率が良くなり、コスト低減も見込め、トランスサーモ異常の細かな対処が可能となるので、安全性や作業性を向上させるという効果がある。さらにまた、本発明のイコライズ機構不用でしかもワークへの当接教示なしの手段によれば、固定側電極の当接位置を簡単に教示でき、当接教示の教示時間の短縮とイコライズ機構の省略でガン設計の自由度の拡大・コストの削除などを見込むことができる。

【図面の簡単な説明】

【図1】本発明が適用されるシステムの一例を表す概念的斜視図

【図2】本発明の第1・第2・第4の実施例における電動スポットガンを示しその一部を切り欠いた側面図

【図3】本発明の第1の実施例の構成を示す部分側面図で

（a）は教示時に基準の電極チップで空打ちして基準位置を登録し、プレイバックして第1の摩耗量を検出する状態図

（b）は基準固定物に可動側電極チップを当接出来るアプローチ位置を、ロボットを動かして教示し、この位置から可動側電極チップを基準固定物に当接させた状態図

【図4】本発明の第2の実施例の構成を示す部分側面図＊で

（a）は教示時に基準の電極チップでティーチングする状態図

（b）はプレイバックした溶接時での実ワークへ当接させた状態図

【図5】本発明の第3の実施例の回路構成を示す概念的斜視図

【図6】本発明の第4の実施例の構成を示す部分側面図で

（a）は教示時に基準の固定側電極チップの基準位置を登録する状態図

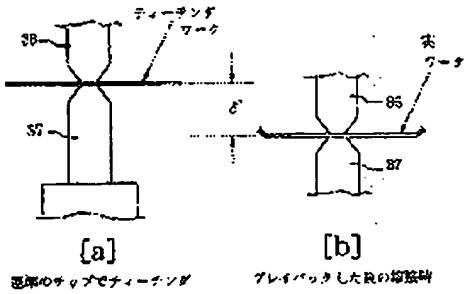
（b）は教示対象ワーク条件（厚み・溶接枚数）を設定し、当接教示する際の状態図

【図7】従来例におけるシステム例を表す概念的斜視図

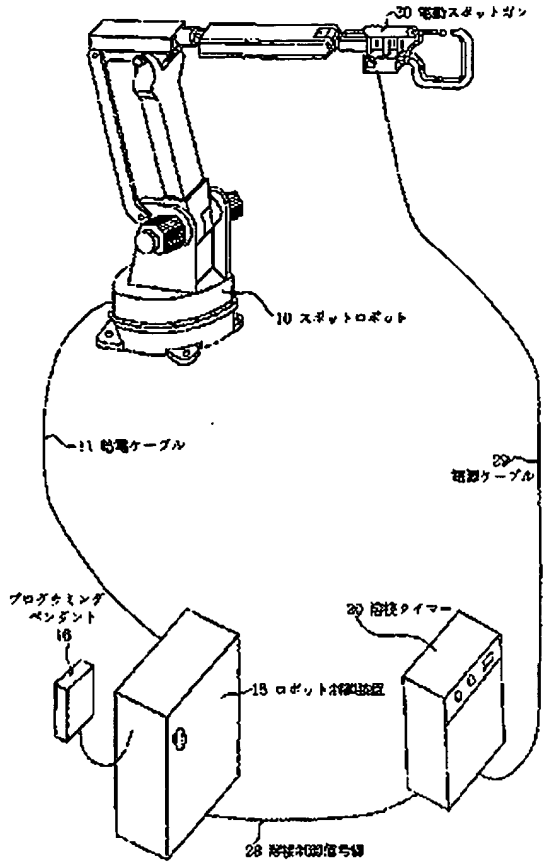
【符号の説明】

10　スポットロボット
11　給電ケーブル（ロボット駆動電源供給用）
15　ロボット制御装置
16　プログラミングペンダント（ロボット用）
20　溶接タイマー
21　基準固定物
22　ガン制御信号ケーブル
23　ガン制御信号線
24　トランスサーモ信号線
25　中継部
28　溶接制御信号
29　電源ケーブル
30　電動スポットガン（またはエアスポットガン）
31　ガンモータ
32　溶接トランス
33　駆動部
34　可動側電極部
35　固定側電極部
36　可動側電極チップ
37　固定側電極チップ

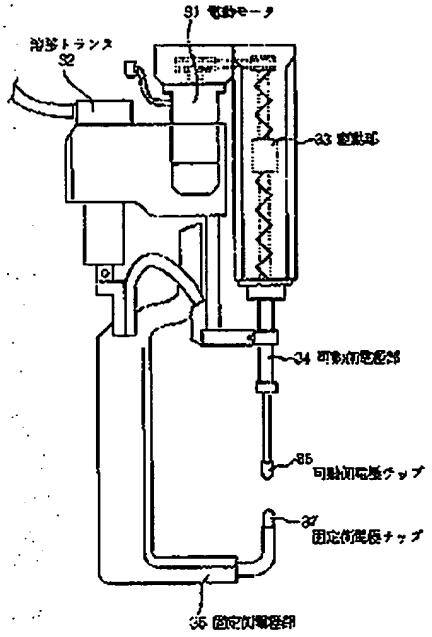
【図4】



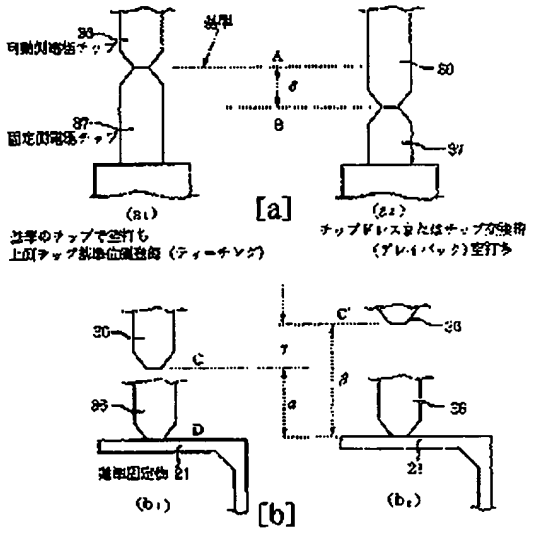
【図１】


30 電動スポットガン
10 スポットロボット
11 給電ケーブル
29 信号ケーブル
プログラミング ペンダント 16
20 溶接タイマー
15 ロボット制御装置
28 溶接制御信号線

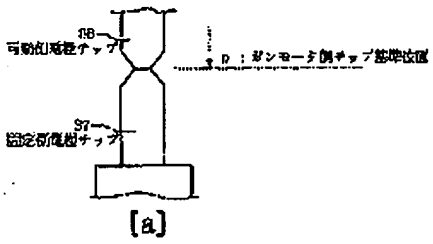
【図２】

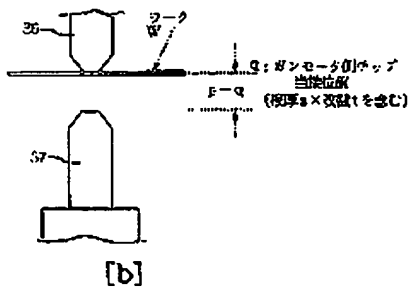

31 電動モータ
溶接トランス 32
33 加圧部
34 可動側電極部
35 可動側電極チップ
37 固定側電極チップ
36 固定側電極部

【図３】

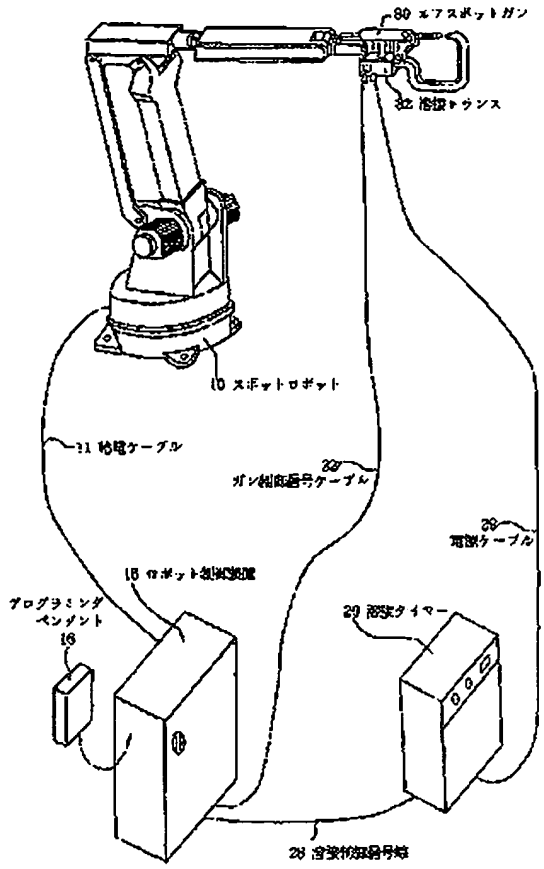

35 可動側電極チップ
基準
A
δ
B
37 固定側電極チップ
[a]
(a1)
基準のチップで溶打ち
上面チップ基準位置調整 (ティーチング)
(a2)
チップドレスまたはチップ交換後
(プレイバック)溶打ち
C'
C
γ
β
α
D
溶接固定物 21
[b]
(b1)
(b2)

【図６】

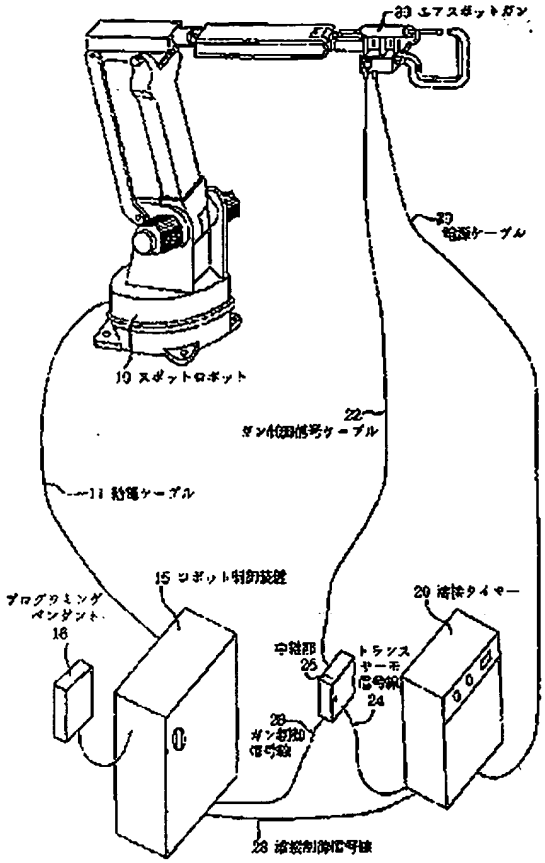

35 可動側電極チップ
p：ガンモータ側チップ基準位置
37 固定側電極チップ
[a]


35
ワーク W
q：ガンモータ側チップ当接位置
p－q
(板厚s×収縮t を含む)
37
[b]

【図5】



【図7】



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